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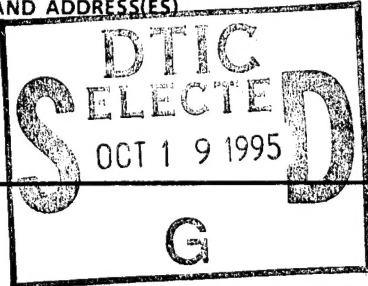
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DEBASISH DUTTA

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
UNIVERSITY OF MICHIGAN
DIVISION OF RESEARCH & DEVELOPMENT
WOLVERINE TOWER/300 S. STATE STREET
ANN ARBOR, MI 48109-1274

PERFORMING ORGANIZATION

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9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

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A cyclide based approach to cable harness design has been developed.

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Next Generation Solid Modellers for Electronic Prototyping

Debasish Dutta
Mechanical Engineering
University of Michigan
Ann Arbor, MI 48109

Tel: (313) 936-3567
Email: Dutta@engin.umich.edu

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1. INTRODUCTION

This research project is continuing and is currently funded by AFOSR. Hence, this report can also be considered as a progress report. The overall focus of this project is to alleviate the geometric domain inadequacy of current solid modelers. Towards that end, we are investigating a new class of surface called the (Dupin) cyclide for incorporation into solid modelers. Cyclides have simple and intuitive geometric parameters, they can be represented in both implicit and parametric form, and their offset surfaces are easy to compute. All existing (CSG) solid modeling primitives (*i.e.*, plane, sphere, cylinder, cone and torus) are special cases of the cyclide giving rise to the possibility of a unified framework for surface interrogations, manipulations and intersections within a solid modeler.

2. RESEARCH RESULTS

In previous years, we developed methodologies for using the cyclide in a solid modelling system to model complex blending surfaces, to assist in pipe layouts, and for synthesizing collision free volumes in 3D. This year, we addressed the following topics.

2.1 Cyclide Blending

In this project, we were given a special blending situation by Dr Steve LeClair of the WP AFB. We were required to develop a cyclide blend of a cube-cylinder intersection (the cylinder was symmetrically placed at one corner of the cube, i.e., making equal angles to all three sides of the cube).

Using our cyclide blending procedures, we developed a piece-wise blending scheme for this intersection. The scheme used six patches of cyclides; three triangular patches from a horned cyclide and three 4-sided patches from a ring cyclide. The procedure was implemented on Silicon Graphics.

2.2 Inspection Using Eddy Current Probes

This is an important problem in the maintenance of aircrafts. The inspection of rotor blades is usually performed by eddy current inspection probes. The planning of this inspection process is very complex and is currently done manually. We carried out initial investigations to determine the feasibility of a computerized planning system that would include the path planning of the robot (probe) arm as well as the appropriate selection of various probes based on the geometry of the part to be inspected.

In this project, we used the C-space approach to path planning and modified an existing 2D algorithm. An example part (CAD file) was supplied by WPAFB which we used for implementation. Results were generated for the motion of the robot arm from a prespecified home position to the inspection location. This program also runs on a Silicon Graphics.

2.3 Cable Harness Design

The problem of designing wire/cable harnesses is an important one in aircraft and spacecraft designs. It is a very tedious process in which designers use past experience to configure the cables. There are no computer tools to assist the designer in this critical task.

We proposed a cyclide based two-step solution to thsi problem. First we generate a "configuration" that satisfies the logic diagram specified by the designer. This is to be achieved via graph theoretic techniques. Next, for this configuration, we route the cable through a collision free path within the environment. A constraint driven cyclide composition scheme is used in the second step.

Each wire bundle is represented as a cyclide tube (which in turn could be composed of several cyclide pieces). It is an interactive scheme in which the harness designer guides the cable while several constraints are automatically satisfied. Examples of constraints include number of junction points, min/max bend radius, min/max cable dia, maximum slack in the cable, etc. These constraints form an optimization problem which is solved using a Sequential Quadratic Programming software.

The initial results obtained this year are very encouraging. We are exploring a full fledged solution to this problem and designing a computer system for cable harnesses.

Phillips Air Force laboratory at the Kirtland AFB has expressed an interest in the cable harness. Also, we have established contacts with Jackson and Tull, Chartered Engineers who are involved in harness design for space shuttles. Visits are planned.

Finally, commercial interest in cyclides have been expressed by Ricoh Corporation's solid modeler DESIGNBASE.

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